Ecology and Environment, Inc.

TDD# F5-8007-5A

Preliminary Hydrogeologic Report on the Federal Marine Terminals Property Riverview, Michigan

by Mark A. Hutson

In accordance with TDD# F5-8007-5A, Ecology and Environment, Inc. has completed an initial hydrogeologic field study of the Federal Marine Terminals property in Riverview, Michigan. Objectives of the study included identification of contaminants present in soils and ground, determination of groundwater flow characteristics, and evaluation of the potential for off-site migration of contaminants.

The property in question is an approximately 30 acre parcel along the Trenton Channel at the Detroit River. It is bounded on the east by the river, on the south by the Riverview boat dock, on the west by Jefferson Avenue, and on the north by the Firestone Steel plant (see locator map). Fill material was deposited on the site by unidentified parties over a period of many years. The exact time frame of filling operations is unknown but believed to be during the 1950's and early 1960's.

Contamination and buried steel drums were encountered by workers during the initial phase of site development for a facility planned by Federal Marine Terminals. Further development was stopped at that time and the site remains inactive to date.

The study, as authorized by the United States Environmental Protection Agency (USEPA), has consisted of three major components involving data collection on the property. These components included geophysical site investigation, soil boring and piezometer installation, and groundwater sampling.

Geophysical Testing

The geophysical testing portion of the study was subcontracted to Technos, Inc. Technos personnel utilized electromagnetic (EM) conductivity and magnetometer methods to characterize the site. EM was used to delineate areas of increased bulk ground conductivity possibly associated with concentrations of pollutants. The magnetometer was used to detect the presence of buried ferrous materials (i.e., steel drums).

Geophysical Testing (continued)

Figure 1 shows the spatial distribution of magnetic anomalies across the site. As is depicted in this figure, the highest accumulation of buried ferrous materials exists in the northeast quadrant of the property. Fewer anomalies were detected across the central portion of the site. The southwest and western portions of the area showed few or no anomalies.

Figures 2A, 2B, and 2C are computer generated, 3-dimensional views of the sites showing relative conductivities of the materials present. Figures 3A and 3B are contour plots of the same data. As seen in these figures, the northeast and eastern portions of the site show significant increases in conductivity. According to Technos, "conductivities about 60 mm/m appear to be indicative of the clays present in the area". These conductivities found in background clays are nearly one order of magnitude less than the conductivies measured on the northeast portion of the site. Figure 3B magnifies areas along the Trenton Channel where areas of high conductivity meet the river.

With this information we were able to design our monitoring network to pick up the major areas of high conductivity while avoiding magnetic anomalies and the possibility of striking a buried metal object while drilling.

Soil Boring and Piezometer Installation

In order to determine the geologic properties of the site and define the cause of the increased conductivities on site, a network of soil borings and piezometer installations was designed. Toledo Testing Laboratory, Inc. was contracted to perform the boring and well installation and also do soil testing. The network (see Plate 1) consisted of 19 borings into which piezometers were installed (see Diagram 1). Soil samples were taken using a standard split spoon sampler from which 8 soil samples were shipped for chemical analysis.

Soil Boring and Piezometer Installation (continued)

Table 1 presents the results of sieve analysis performed on soil samples from borings 7, 10, and 18. Shelby tube samples of the underlying clay were obtained from borings #16, 17 and 19, and Table 2 presents the results of permeability tests which were run on these samples. As would be expected with filled areas, the composition of the soils varies greatly. However, the clay was observed to have a permeability of approximately 2 x 10^{-8}cm/sec in all three tested samples. All previously completed on-site soils investigations have shown the clay to be 30'-50' thick. In order to obtain a representative value of permeability of the fill material, in-situ falling head tests were performed in wells #3 and 7. These tests (see Appendix B) resulted in values of 5 x 10^{-5}cm/sec in well #7 and approxiamtely 3.5 x 10^{-5} in well #3. Values in this range are normal for materials composed of silty sands[2].

Logs of the soil borings (Appendix A) reveal a clay-fill interface surface as shown on Plate 2. Several of the borings penetrated a soft, black, organic layer at approximate elevation 573-574. As this elevation coincides with approximate river level and the lateral extent of this organic layer is relatively extensive, it is believed that this elevation represents the deepest extent of fill material. Sand and gravel deposits below the organics probably represents naturally deposited alluvial materials. The northwestward trending depression across the clay suggests the presence of the ancestral Monguagon Creek across the property at this location. Cross section A-A' and B-B' show the generalized subsurface profiles from the locations marked on Plate 1.

Plate 3 is a contour plot of the piezometric surface as defined by water level measurements taken on 2/24/81 and 2/27/81. As outlined in Appendix C, the volume of water flowing from the site into the Trenton Channel is approximately 56,000 gallons/year at an estimated velocity of 4 feet/year. It should be emphasized that these figures represent estimates based on the assumptions outlined in Appendix C. Additional groundwater flow is noted from the western portions of the fill toward the north and northeast. The relative elevations of the piezometric surface and river level suggest that at the time this data was collected,

Soil Boring and Piezometer Installation (continued)

water was moving from the channel into the near stream alluvial deposits and fill material. This phenomena reinforces the suggestion of a positive link between the groundwater on the site and the river. Communication between the two will naturally result in occasional recharge of the groundwater in this manner.

Conclusions

From the data which has been gathered to date, the geologic setting of the FMT property can be outlined. The entire site is underlain by a stiff clay layer which extends for 30'-50' below the fill and has a measured permeability on the order of approximately 2×10^{-8}cm/sec. This layer should be sufficient to prevent vertical migration of contaminants. The clay surface is overlain by sand and gravel deposits, some of which are probably naturally occurring alluvial deposits of the Trenton Channel or ancestral Monguagon Creek. The organic layer encountered in several borings probably represents the uppermost horizon of these alluvial deposits and marks the lowest extent of filled materials.

The soils encountered in the filled areas ranged from gravels to silty sands. Evaluation of falling head tests on two of the wells yielded values on the order of 10^{-5}cm/sec. Horizontal movement of groundwater into the river will be approximately 0.1 gal/minute. At flow rates in this range, there is little possibility of detecting any contamination in the river. Flow from the western sections of the fill is in a northerly direction.

More information on the site will be available when chemical analysis of soil and water samples are received. At that time, this report will be updated to include that information.

Recommendations

In order to ascertain the extent of contamination extending off-site in a northerly direction, additional boring and sampling would need to be completed.

If an absolute proof of communication between the river and groundwater is required, river and groundwater level recording devices will have to be installed on-site. The estimated cost of this would be approximately $12,000 plus approximately 40 man-days for installation. An additional cost would be that required to send technicians to Detroit once a week for the duration of the records, (at least 6 months).

MH/df

REFERENCES

[1] Technos, Inc., 1980, "Report of Geophysical Investigation at F.M.T., Firestone, and McLouth Steel Properties", Detroit, Michigan.

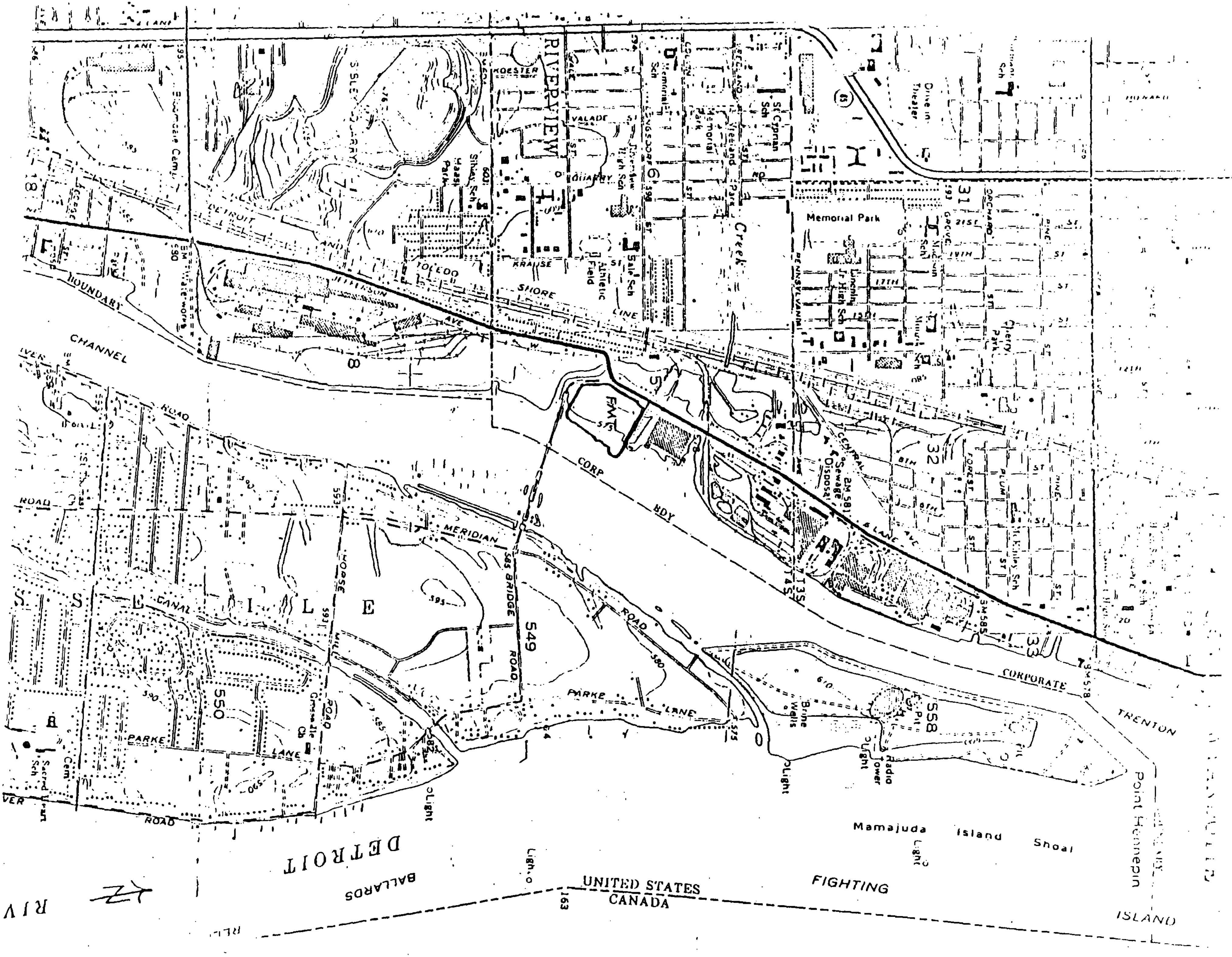
[2] Freeze, R. Allan and Cherry, John A., 1979, "Groundwater", Prentice-Hall, Inc., Englewood Cliffs, N.J., p. 29

Dames and Moore, 1979, "Investigation of Potential Contamination - Firestone Site", Riverview, Michigan.

Applied Environmental Research, 1979, "Federal Marine Terminals, Inc. site Environmental Assessment", Riverview, Michigan.

Walton, W.C., 1970, Groundwater Resource Evaluation, McGraw Hill Book Company, p. 664

MH/df



RIVERVIEW
Memorial Park
Memorial Sch
Riverview High Sch
Athletic Field
Drive in Theater
Lincoln Jr High Sch
Cherry Park
Creek
DETROIT
AND
TOLEDO
SHORE
LINE
JEFFERSON
AVE
BOUNDARY
CHANNEL
MERIDIAN
BRIDGE
ROAD
CANAL
PARKE
LANE
CORP
BDY
CORPORATE
TRENTON
Sewage Disposal
Brine Wells
Radio Tower
Light
Mamajuda
Island
Shoal
Point Hennepin
DETROIT
BALLARDS
UNITED STATES
CANADA
FIGHTING
ISLAND

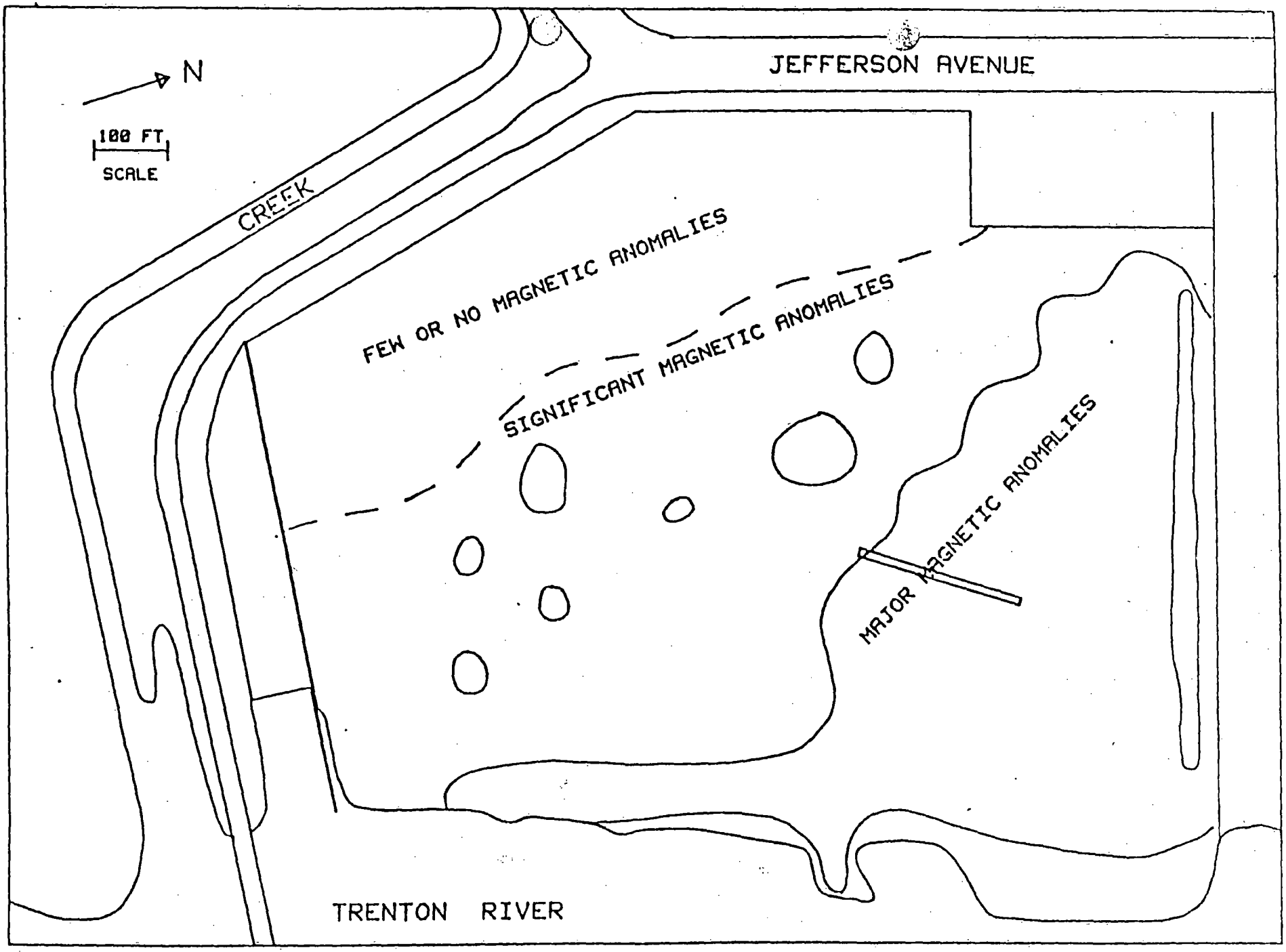


Figure 1 : F.M.T. Site; Magnetic Anomaly Distribution
Significant Anomalies — — — Major Anomalies ———

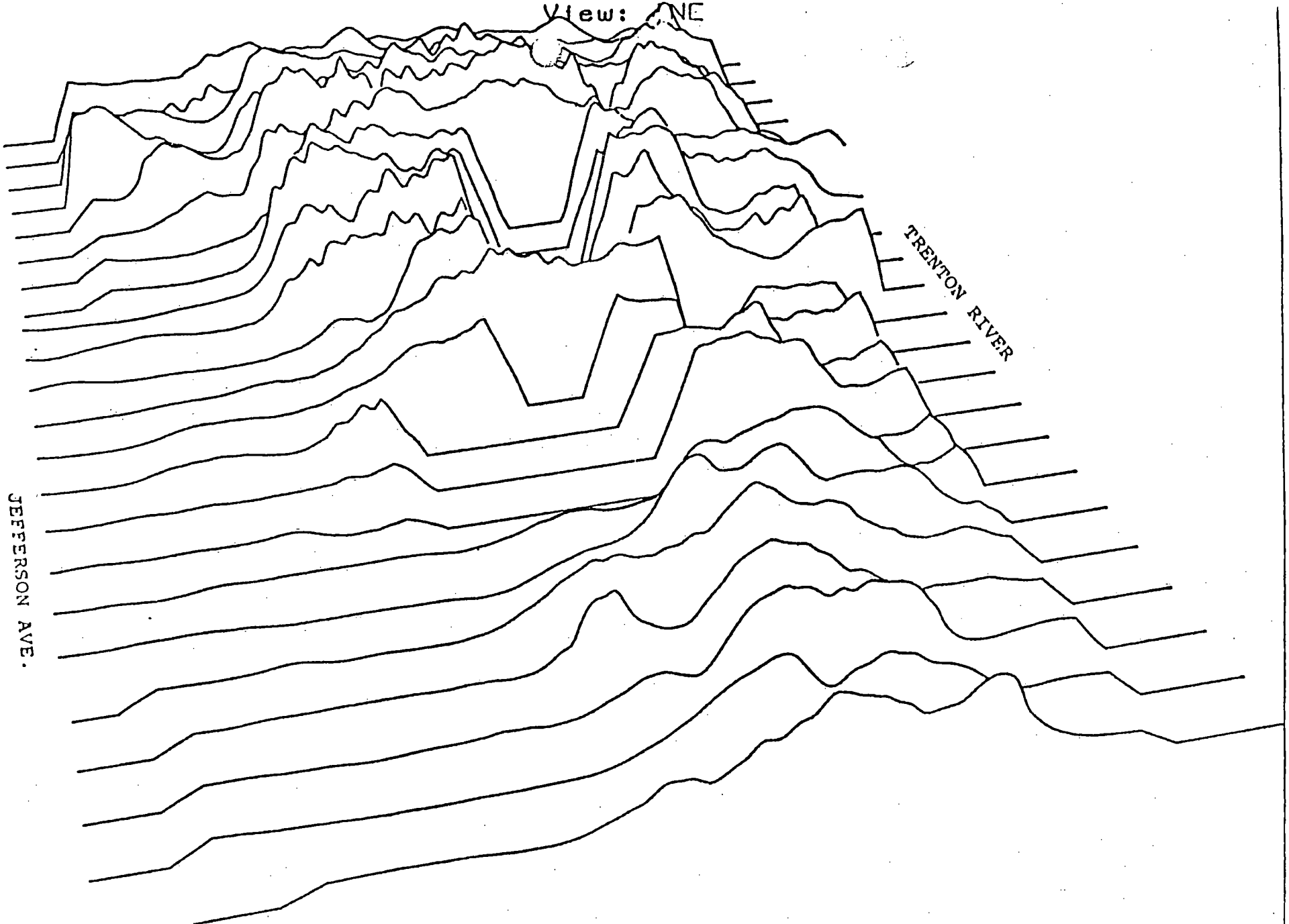


Figure 2A: F.M.T. Site; 3-Dimensional Conductivity Plot, northeast view.
Figure is approximately to scale, 1000 by 1200 feet.

GROUND CONDUCTIVITY

TECHNOS INC, MIAMI

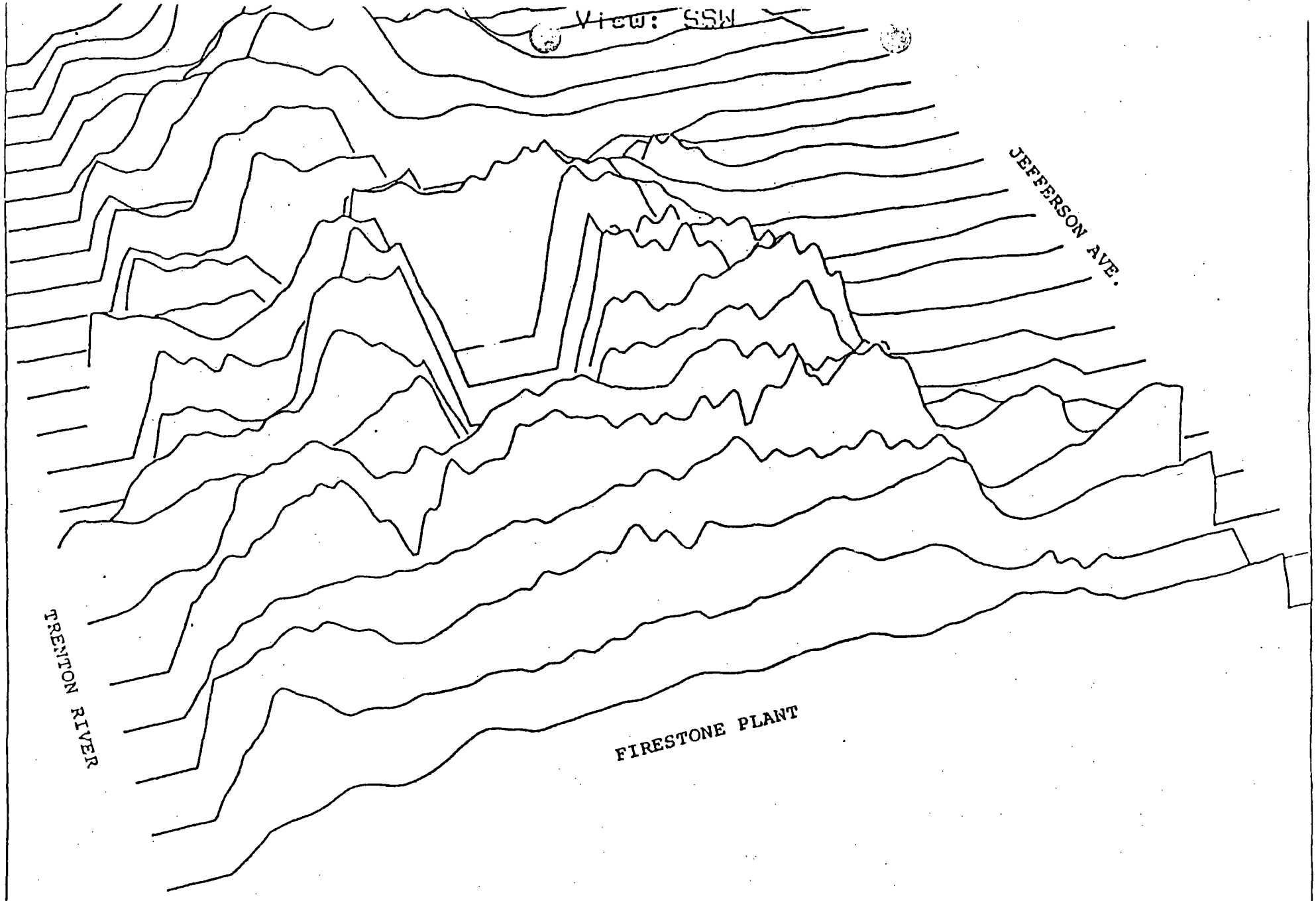


Figure 2B: F.M.T. Site; 3-Dimensional Conductivity Plot, south-southwest view.
Figure is approximately to scale, 100 by 1200 feet.

GROUND CONDUCTIVITY

TECHNOS INC, MIAMI

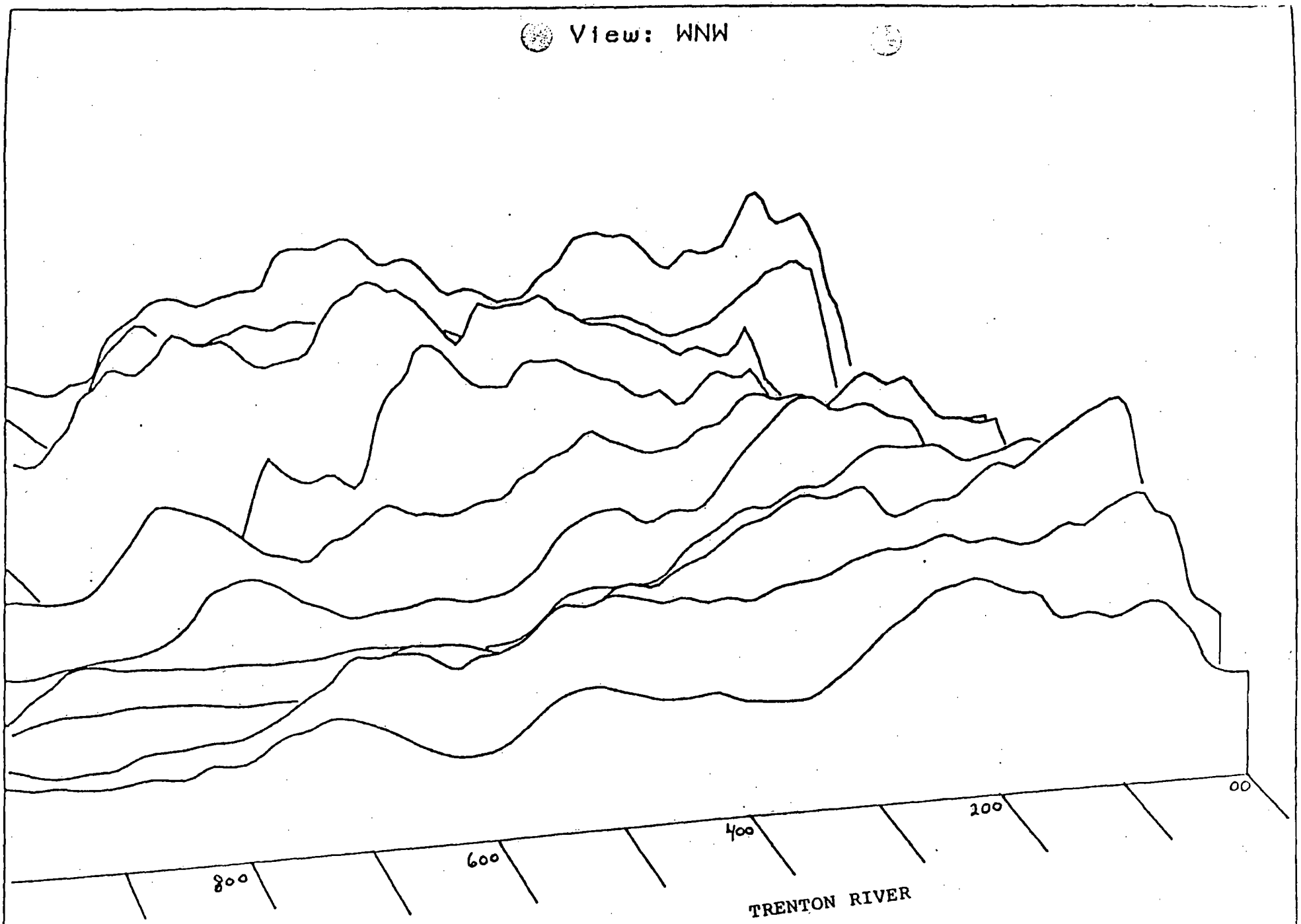


Figure 2C: F.M.T. Site; 3-Dimensional Conductivity Plot, Northeast corner.
Indicated scale is in feet.

GROUND CONDUCTIVITY

TECHNOS INC, MIAMI.

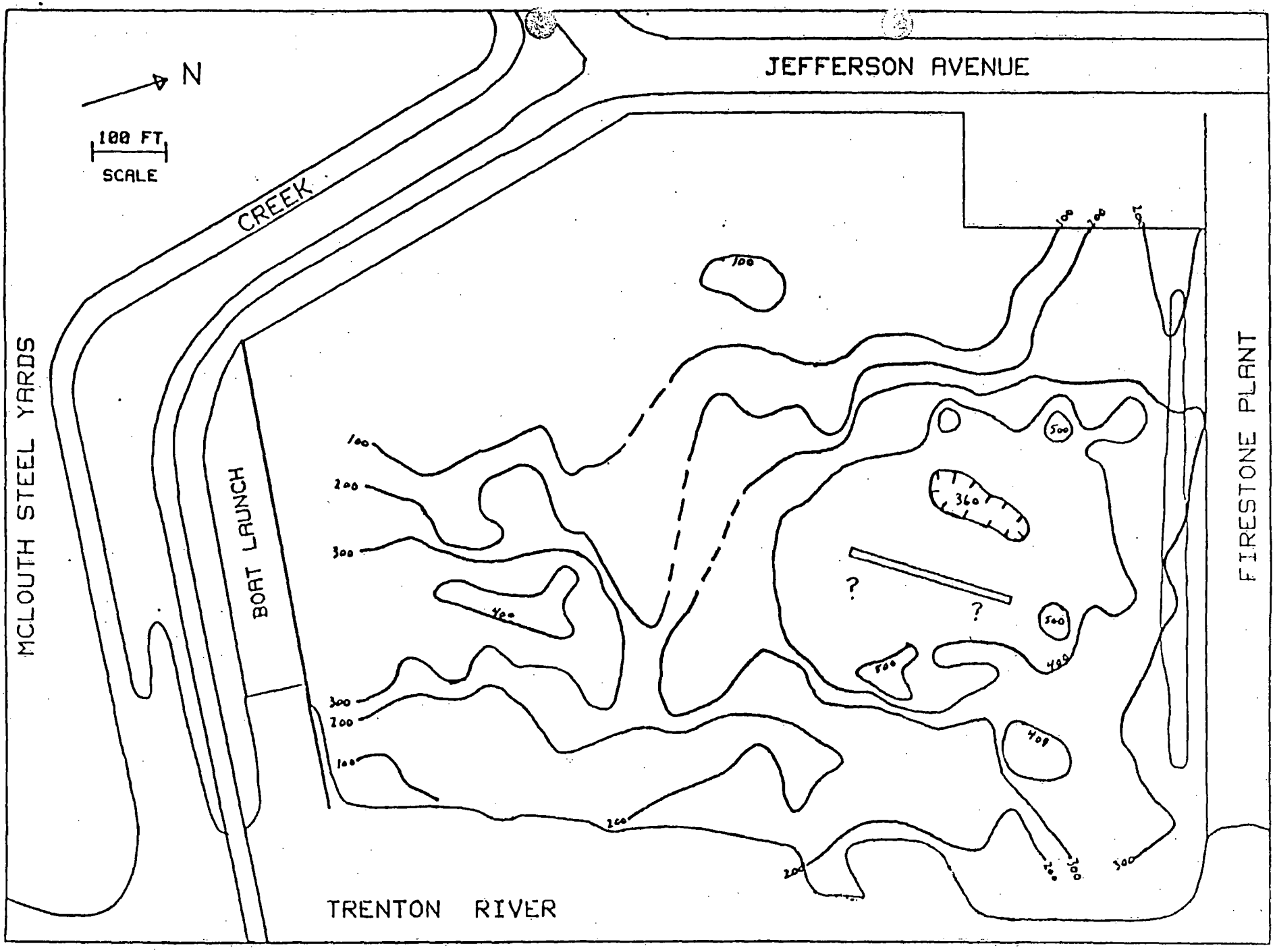


Figure 3A: F.M.T. Site; Generalized Ground Conductivity Contour Plot.

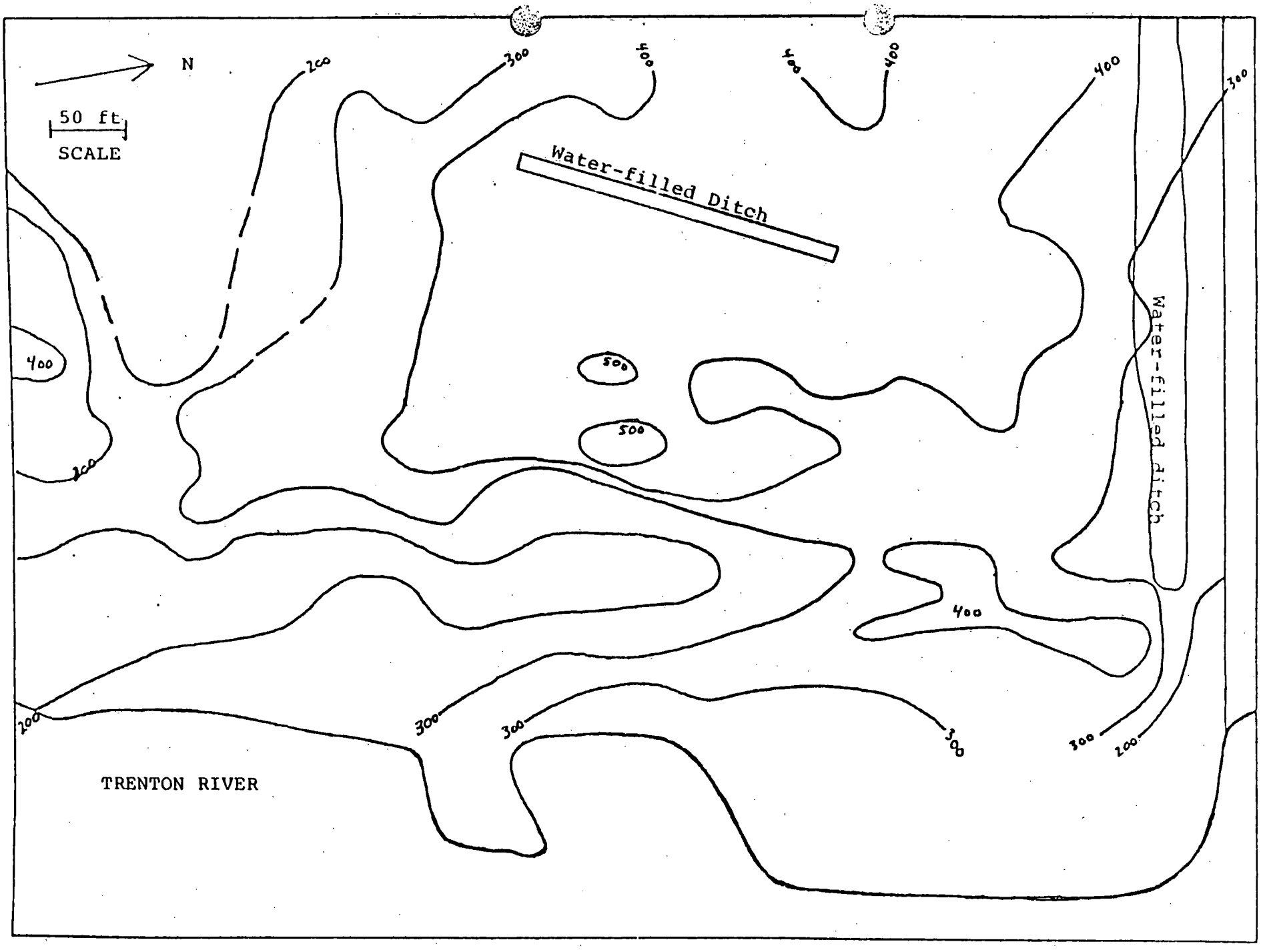
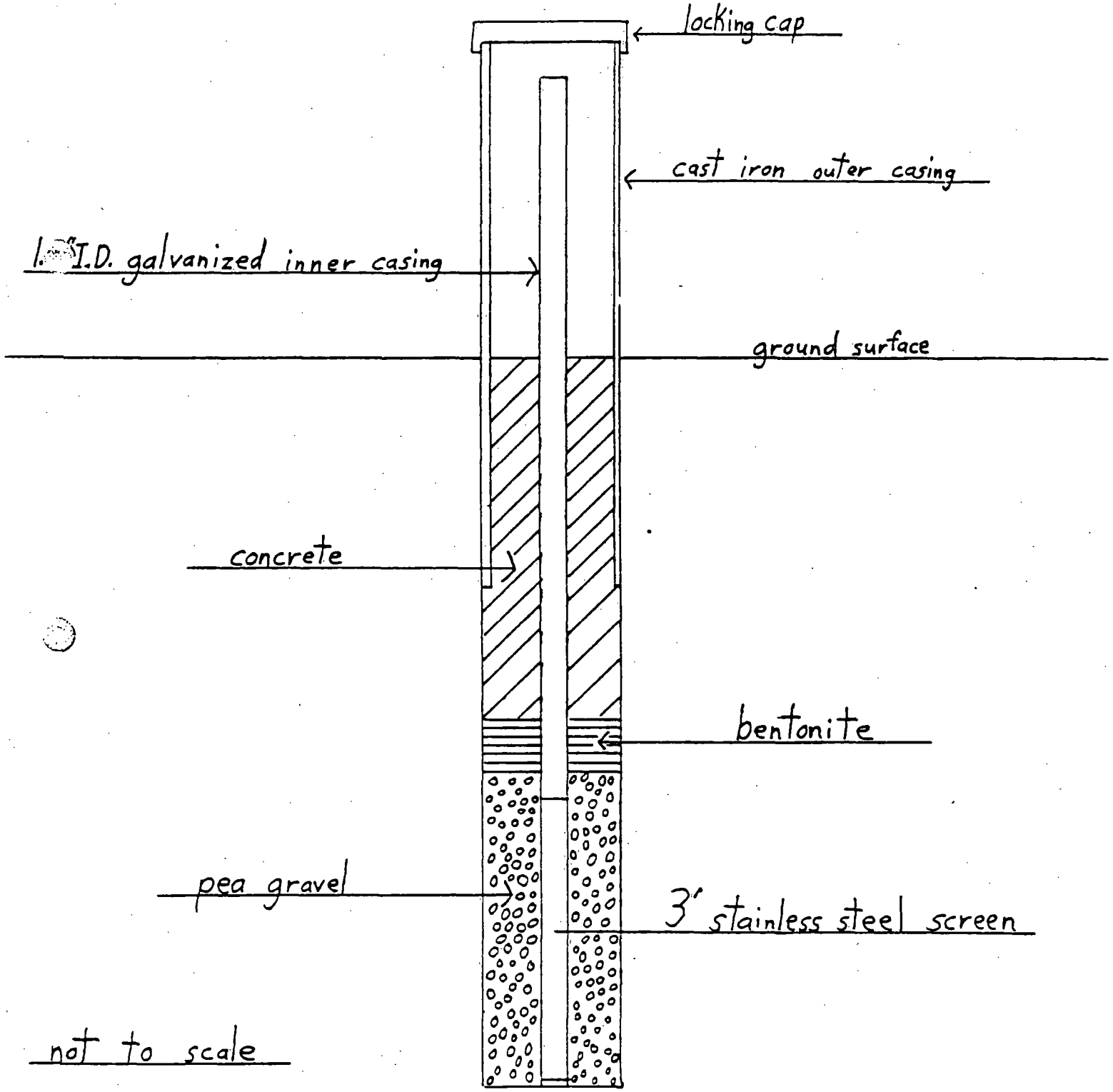


Figure 3B: F.M.T. Site; Generalized Ground Conductivity Contour Plot Northeast corner.

Federal Marine Terminals



Toledo Testing Laboratory, Inc.
Engineers • Chemists • Geologists

1810 North 12th Street
Toledo, Ohio 43624

FEBRUARY 6, 1981

T.T.L. JOB NO. DR-4686

TABLE NO. 1

MECHANICAL ANALYSIS (SIEVE AND HYDROMETER) AND COMPOSITION OF SOIL

SIEVE ANALYSIS
PERCENT PASSING SIEVE SIZES AND NUMBERS

BORING NUMBER	1 1/2"	1"	3/4"	1/2"	3/8"	NO.4	NO.10	NO.20	NO.40	NO.100	NO.
-A	100.00	100.00	100.00	100.00	100.00	99.91	99.45	99.36	99.24	77.63	53.
-B	100.00	100.00	100.00	100.00	100.00	99.47	98.25	97.55	97.08	42.86	21.
-D	100.00	90.66	86.91	80.76	75.46	63.51	47.49	39.03	33.77	26.99	22.

COMPOSITION OF SOIL

BORING NUMBER	GRAVEL (%)	SAND (%)	FINES SILT (%)	FINES CLAY (%)
7-A	0.55	45.76	34.21	19.48
10-B	1.75	76.52	10.70	11.03
18-D	52.51	25.34	10.54	11.61

TABLE NO. 2

PERMEABILITY TEST

BORING NUMBER	SAMPLE NUMBER	DEPTH (FT.-IN.)	NATURAL MOISTURE CONTENT (%)	COEFFICIENT OF PERMEABILITY (cm/sec)
16	ST-1	4'4"-6'0"	15.4	2.0×10^{-8}
17	C	14'0"-15'6"	15.5	1.8×10^{-8}*
19	ST-1	5'9"-6'10"	18.4	2.1×10^{-8}

*Sample remolded and consolidated at the approximate overburden pr
$\bar{\sigma}_v$ = 1,500 psf for 24 hours prior to test.

Appendix

SOIL BORING LOG

Toledo Testing Laboratory, Inc
1810 North 12th Street
Toledo, Ohio 43624
(419) 241-7175

Project WELL INSTALLATION - RIVERVIEW, MICHIGAN

Boring Location _____ Job No. DR-4686

Date JANUARY 14, 1981 Soil Borin

Sample & Type	Depth (Ft.-In.)	Top of well cap - Elevation: 590.60 Soil Description	Blows Per 6"	Moisture Content (%)	Dry Unit Weight (P.C.F.)	Unconfined Compressive Strength (P.S.F.)
	1'0"	Fill - medium stiff brown silty clay	(3)			
NO.1 J			(3)			
	2'6"		(3)			
	3'6"	Fill - medium stiff grey silty clay				
NO.2 J			(2)			
	5'0"		(3)			
			(4)			

Type of Sample

A Auger (Disturbed)
—Split Tube Sampling—
H Thin-walled (Housel) Tube-Undisturbed
J Jar-Disturbed
ST Shelby Tube-Undisturbed
RC Rock Core
NR Indicates "No Recovery"

Remarks

Total Footage: 5'0"
Overburden Drilled: 5'0"
Rock Cored: NONE
Drillers: TK-TB-DF

Groundwater Observations

At completion: 3'6" below the surface

SOIL BORING LOG

Toledo Testing Laboratory, Inc.
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(419) 241-7175

Project WELL INSTALLATION - RIVERVIEW, MICHIGAN

Boring Location _____ Job No. DR-4686

Date JANUARY 15, 1981 Soil Boring No. 2

Sample & Type	Depth (Ft.-In.)		Top of well cap - Elevation: 589.95 Soil Description	Blows Per 6"	Moisture Content (%)	Dry Unit Weight (P.C.F.)	Unconfined Compressive Strength (P.S.F.)	Allowable Bearing Strength (P.S.F.)
	1'6"							
NO. 1			Fill - very loose dark brown sand and gravel	(6)				
J1				(2)				
	3'0"			(1)				
	4'0"							
NO. 2				(5)				
J1	5'0"			(3)				
	5'6"		Soft brown silty clay	(2)				

Type of Sample
- A Auger (Disturbed) —Split Tube Sampling—
- H Thin-walled (Housel) Tube-Undisturbed
- J Jar-Disturbed
- ST Shelby Tube-Undisturbed
- RC Rock Core
- NR Indicates "No Recovery"

Remarks
- Total Footage: 5'6"
- Overburden Drilled: 5'6"
- Rock Cored: NONE
- Drillers: TK-TB-DF

Groundwater Observations

SOIL BORING LOG

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Project WELL INSTALLATION - RIVERVIEW, MICHIGAN

Boring Location _____ Job No. DR-4686

Date JANUARY 15, 1981 Soil Boring No. 3

Sample & Type	Depth (Ft.-In.)	Top of well cap - Elevation: 589.93 Soil Description	Blows Per 6"	Moisture Content (%)	Dry Unit Weight (P.C.F.)	Unconfined Compressive Strength (P.S.F.)	Allowable Bearing Strength (P.S.F.)
	1'6"	Fill - Medium dense brown sand and gravel					
NO.1 J			(10) (7) (5)				
	3'0"						
	4'0"						
NO.2 J			(2) (1)				
	5'6"	Fill - very loose sand, gravel and clay	(1)				
	8'6"						
	9'0"						
NO.3 J		Medium stiff grey silty, sandy clay	(2) (2)				
	10'6"		(3)				

Type of Sample

A Auger (Disturbed) —Split Tube Sampling—
H Thin-walled (Housel) Tube-Undisturbed
J Jar-Disturbed
ST Shelby Tube-Undisturbed
RC Rock Core
NR Indicates "No Recovery"

Remarks

Total Footage: 10'6"
Overburden Drilled: 10'6"
Rock Cored: NONE
Drillers: TK-TB-DF

Groundwater Observations

SOIL BORING LOG

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Project WELL INSTALLATION - RIVERVIEW, MICHIGAN

Boring Location _____ Job No. DR-4686

Date JANUARY 15, 1981 Soil Boring No. 4

Sample & Type	Depth (Ft.-In.)		Top of well cap - Elevation: 589.23 Soil Description	Blows Per 6"	Moisture Content (%)	Dry Unit Weight (P.C.F.)	Unconfined Compressive Strength (P.S.F.)	Allowable Bearing Strength (P.S.F.)
			Fill - dark brown sand, gravel, clay, rock and brick					
	4'0"			(15)				
NO.1 J				(15)				
	5'6"			(9)				
	6'0"							

Type of Sample
- A Auger (Disturbed) —Split Tube Sampling—
- H Thin-walled (Housel) Tube-Undisturbed
- J Jar-Disturbed
- ST Shelby Tube-Undisturbed
- RC Rock Core
- NR Indicates "No Recovery"

Remarks
- Total Footage: 6'0"
- Overburden Drilled: 6'0"
- Rock Cored: NONE
- Drillers: TK-TB-DF

Groundwater Observations

SOIL BORING LOG

Toledo Testing Laboratory, Inc.
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Project WELL INSTALLATION - RIVERVIEW, MICHIGAN

Boring Location _____ Job No. DR-4686

Date JANUARY 15, 1981 Soil Boring No. 5

Sample & Type	Depth (Ft.-In.)	Top of well cap - Elevation: 590.42 Soil Description	Blows Per 6"	Moisture Content (%)	Dry Unit Weight (P.C.F.)	Unconfined Compressive Strength (P.S.F.)	Allowable Bearing Strength (P.S.F.)
	4'0"	Fill - very loose dark brown sand and gravel	(4)				
NO.1 J			(1)				
	5'6"		(1)				
	7'6"						
	9'0"	Soft grey silty clay	(1)				
NO.2 J			(2)				
	10'6"		(2)				
	11'6"						
	13'6"	Hard brown and grey mottled silty clay, some gravel	(14)				
NO.3 J			(10)				
	15'0"		(17)				

Type of Sample

A Auger (Disturbed) —Split Tube Sampling—
H Thin-walled (Housel) Tube-Undisturbed
J Jar-Disturbed
ST Shelby Tube-Undisturbed
RC Rock Core
NR Indicates "No Recovery"

Remarks

Total Footage: 15'0"
Overburden Drilled: 15'0"
Rock Cored: NONE
Drillers: TK-TB-DF

Groundwater Observations

SOIL BORING LOG

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Project WELL INSTALLATION - RIVERVIEW, MICHIGAN

Boring Location _____ Job No. DR-4686

Date JANUARY 16, 1981 Soil Boring No. 6

Sample & Type	Depth (Ft.-In.)	Soil Description	Blows Per 6"	Moisture Content (%)	Dry Unit Weight (P.C.F.)	Unconfined Compressive Strength (P.S.F.)	Allowable Bearing Strength (P.S.F.)
		Top of well cap - Eelevation: 590.18					
		Fill - loose brown sand and gravel, trace of clay					
	4'0"						
NO.1			(3)				
J			(3)				
	5'6"		(3)				
	6'0"						

Type of Sample
A Auger (Disturbed)
—Split Tube Sampling—
H Thin-walled (Housel) Tube-Undisturbed
J Jar-Disturbed
ST Shelby Tube-Undisturbed
RC Rock Core
NR Indicates "No Recovery"

Remarks
Total Footage: 6'0"
Overburden Drilled: 6'0"
Rock Cored: NONE
Drillers: TK-TB-DF

Groundwater Observations

SOIL BORING LOG

Toledo Testing Laboratory, Inc.
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Project WELL INSTALLATION - RIVERVIEW, MICHIGAN

Boring Location _____ Job No. DR-4686

Date JANUARY 16, 1981 Soil Boring No. 7

Sample & Type	Depth (Ft.-In.)	Top of well cap - Elevation: 590.39 Soil Description	Blows Per 6"	Moisture Content (%)	Dry Unit Weight (P.C.F.)	Unconfined Compressive Strength (P.S.F.)	Allowable Bearing Strength (P.S.F.)
	2'0"	Fill - brown sand, gravel and stone					
NO.1 J	4'0" 5'6"	Soft black sand and silt, some clay and organics	(1) (1) (2)				
NO.2 A.J	9'0" 10'6"	Medium stiff brown sand and silt, little clay, trace of gravel	(1) (2) (4)				

Type of Sample

A Auger (Disturbed) —Split Tube Sampling—
H Thin-walled (Housel) Tube-Undisturbed
J Jar-Disturbed
ST Shelby Tube-Undisturbed
RC Rock Core
NR Indicates "No Recovery"

Remarks

Total Footage: 10'6"
Overburden Drilled: 10'6"
Rock Cored: NONE
Drillers: TK-TB-DF

Groundwater Observations

SOIL BORING LOG

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Project WELL INSTALLATION - RIVERVIEW, MICHIGAN

Boring Location _____ Job No. DR-4686

Date JANUARY 16, 1981 Soil Boring No. 8

Sample & Type	Depth (Ft.-In.)		Soil Description	Blows Per 6"	Moisture Content (%)	Dry Unit Weight (P.C.F.)	Unconfined Compressive Strength (P.S.F.)	Allowable Bearing Strength (P.S.F.)
			Top of well cap - Elevation: 589.45					
			Fill - loose brown and black sand, gravel and clay					
	4'0"							
NO.1				(4)				
J				(2)				
	5'6"			(4)				
	7'0"							

Type of Sample

A Auger (Disturbed)
—Split Tube Sampling—
H Thin-walled (Housel) Tube-Undisturbed
J Jar-Disturbed
ST Shelby Tube-Undisturbed
RC Rock Core
NR Indicates "No Recovery"

Remarks

Total Footage: 7'0"
Overburden Drilled: 7'0"
Rock Cored: NONE
Drillers: TK-TB-DF

Groundwater Observations

SOIL BORING LOG

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Project WELL INSTALLATION - RIVERVIEW, MICHIGAN

Boring Location _____ Job No. DR-4686

Date JANUARY 16, 1981 Soil Boring No. 9

Sample & Type	Depth (Ft.-In.)		Soil Description	Blows Per 6"	Moisture Content (%)	Dry Unit Weight (P.C.F.)	Unconfined Compressive Strength (P.S.F.)	Allowable Bearing Strength (P.S.F.)
			Top of well cap - Elevation: 591.00					
			Fill - brown sand and gravel					
	2'0"							
			Loose brown and black sand and gravel, trace of silty clay					
	4'0"							
NO.1 J				(6) (2) (4)				
	5'6"							
	6'0"							

Type of Sample
A Auger (Disturbed) —Split Tube Sampling—
H Thin-walled (Housel) Tube-Undisturbed
J Jar-Disturbed
ST Shelby Tube-Undisturbed
RC Rock Core
NR Indicates "No Recovery"

Remarks
Total Footage: 6'0"
Overburden Drilled: 6'0"
Rock Cored: NONE
Drillers: TK-TB-DF

Groundwater Observations

SOIL BORING LOG

Toledo Testing Laboratory, Inc.
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(419) 241-7175

Project WELL INSTALLATION - RIVERVIEW, MICHIGAN

Boring Location _____ Job No. DR-4686

Date JANUARY 21, 1981 Soil Boring No. 10

Sample & Type	Depth (Ft.-In.)		Top of wall cap - Elevation: 590.93 Soil Description	Blows Per 6"	Moisture Content (%)	Dry Unit Weight (P.C.F.)	Unconfined Compressive Strength (P.S.F.)	Allowable Bearing Strength (P.S.F.)
			Light brown sand, gravel and stones					
	4'0"							
NO.1				(7)				
J				(7)				
	5'6"			(9)				
	7'0"							
			Very soft black organic muck					
	8'6"							
	9'0"							
NO.2				(3)				
J				(2)				
	10'6"			(2)				
			Fill - loose black sand, little silt and clay, trace of gravel					
	14'0"							
NO.3				(4)				
B, J				(2)				
	15'6"			(3)				

Type of Sample

A Auger (Disturbed)
—Split Tube Sampling—
H Thin-walled (Housel) Tube-Undisturbed
J Jar-Disturbed
ST Shelby Tube-Undisturbed
RC Rock Core
NR Indicates "No Recovery"

Remarks

Total Footage: 15'6"
Overburden Drilled: 15'6"
Rock Cored: NONE
Drillers: TK-TB-DF

Groundwater Observations

SOIL BORING LOG

Toledo Testing Laboratory, Inc.
1810 North 12th Street
Toledo, Ohio 43624
(419) 241-7175

Project WELL INSTALLATION - RIVERVIEW, MICHIGAN

Boring Location _____ Job No. DR-4686

Date JANUARY 21, 1981 Soil Boring No. 11

Sample & Type	Depth (Ft.-In.)		Top of wall cap - Elevation: 589.76 Soil Description	Blows Per 6"	Moisture Content (%)	Dry Unit Weight (P.C.F.)	Unconfined Compressive Strength (P.S.F.)	Allowable Bearing Strength (P.S.F.)
	2'0"		Fill - loose black sand and gravel, brick and rock					
NO.1				(6)				
				(5)				
	3'6"			(3)				
	5'0"		Black sand and gravel					
	8'6"							

e of Sample
Auger (Disturbed)
Split Tube Sampling—
Thin-walled (Housel)
Tube-Undisturbed
ar-Disturbed
helby Tube-Undisturbed
ock Core
dicates "No Recovery"

Remarks

Total Footage: 8'6"
Overburden Drilled: 8'6"
Rock Cored: NONE
Drillers: TK-TB-DF

Groundwater Observations

SOIL BORING LOG

Toledo Testing Laboratory, Inc.
1810 North 12th Street
Toledo, Ohio 43624
(419) 241-7175

Project WELL INSTALLATION - RIVERVIEW, MICHIGAN

Boring Location _____ Job No. DR-4686

Date JANUARY 21, 1981 Soil Boring No. 12

Sample & Type	Depth (Ft.-In.)		Top of wall cap - Elevation: 590.86 Soil Description	Blows Per 6"	Moisture Content (%)	Dry Unit Weight (P.C.F.)	Unconfined Compressive Strength (P.S.F.)	Allowable Bearing Strength (P.S.F.)
			Loose brown and white sand and gravel					
	4'0"							
NO.1				(1)				
J				(1)				
	5'6"			(4)				
	6'0"							

Type of Sample
A Auger (Disturbed) —Split Tube Sampling—
H Thin-walled (Housel) Tube-Undisturbed
J Jar-Disturbed
ST Shelby Tube-Undisturbed
RC Rock Core
NR Indicates "No Recovery"

Remarks
Total Footage: 6'0"
Overburden Drilled: 6'0"
Rock Cored: NONE
Drillers: TK-TB-DF

Groundwater Observations

SOIL BORING LOG

Toledo Testing Laboratory, Inc.
1810 North 12th Street
Toledo, Ohio 43624
(419) 241-7175

Project WELL INSTALLATION - RIVERVIEW, MICHIGAN

Boring Location _____ Job No. DR-4686

Date JANUARY 21, 1981 Soil Boring No. 13

Sample & Type	Depth (Ft.-In.)		Top of wall cap - Elevation: 591.04 Soil Description	Blows Per 6"	Moisture Content (%)	Dry Unit Weight (P.C.F.)	Unconfined Compressive Strength (P.S.F.)	Allowable Bearing Strength (P.S.F.)
			Fill - dark brown sand, gravel, rock brick and steel					
	5'6"							
NO.1 J				(1) (19)				
	7'0"			(12)				
	8'6"							

Type of Sample
A Auger (Disturbed)
—Split Tube Sampling—
H Thin-walled (Housel) Tube-Undisturbed
J Jar-Disturbed
ST Shelby Tube-Undisturbed
RC Rock Core
NR Indicates "No Recovery"

Remarks
Total Footage 8'6"
Overburden Drilled: 8'6"
Rock Cored: NONE
Drillers: TK-TB-DF

Groundwater Observations

SOIL BORING LOG

Toledo Testing Laboratory, Inc.
1810 North 12th Street
Toledo, Ohio 43624
(419) 241-7175

Project WELL INSTALLATION - RIVERVIEW, MICHIGAN

Boring Location _____ Job No. DR-4686

Date JANAURY 21, 1981 Soil Boring No. 14

Sample & Type	Depth (Ft.-In.)		Soil Description	Blows Per 6"	Moisture Content (%)	Dry Unit Weight (P.C.F.)	Unconfined Compressive Strength (P.S.F.)	Allowable Bearing Strength (P.S.F.)
			Top of well cap - Elevation: 591.85					
			Fill - black sand, gravel and stone					
	4'0"							
NO.1 J								
	5'6"							
	6'0"							

Type of Sample

A Auger (Disturbed) —Split Tube Sampling—
H Thin-walled (Housel) Tube-Undisturbed
J Jar-Disturbed
ST Shelby Tube-Undisturbed
RC Rock Core
NR Indicates "No Recovery"

Remarks

Total Footage: 6'0"
Overburden Drilled: 6'0"
Rock Cored: NONE
Drillers: TK-TB-DF

Groundwater Observations

SOIL BORING LOG

Toledo Testing Laboratory, Inc.
1810 North 12th Street
Toledo, Ohio 43624
(419) 241-7175

Project WELL INSTALLATION - RIVERVIEW, MICHIGAN

Boring Location _____ Job No. DR-4686

Date JANUARY 21, 1981 Soil Boring No. 15

Sample & Type	Depth (Ft.-In.)	Soil Description	Blows Per 6"	Moisture Content (%)	Dry Unit Weight (P.C.F.)	Unconfined Compressive Strength (P.S.F.)	Allowable Bearing Strength (P.S.F.)
		Top of well cap - Elevation: 591.77					
		Fill - sand, gravel and brick					
	3'0"						
		Black sand and organic muck					
	4'0"						
NO 1		Medium stiff black sandy clay	(4)				
J			(5)				
	5'6"		(3)				
	6'0"						

Type of Sample

A Auger (Disturbed) —Split Tube Sampling—
H Thin-walled (Housel) Tube-Undisturbed
J Jar-Disturbed
ST Shelby Tube-Undisturbed
RC Rock Core
NR Indicates "No Recovery"

Remarks

Total Footage: 6'0"
Overburden Drilled: 6'0"
Rock Cored: NONE
Drillers: TK-TB-DF

Groundwater Observations

SOIL BORING LOG

Toledo Testing Laboratory, Inc.
1810 North 12th Street
Toledo, Ohio 43624
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Project WELL INSTALLATION - RIVERVIEW, MICHIGAN

Boring Location _____ Job No. DR-4686

Date JANUARY 22, 1981 Soil Boring No. 16

Sample & Type	Depth (Ft.-In.)		Top of well cap - Elevation: 591.17 Soil Description	Blows Per 6"	Moisture Content (%)	Dry Unit Weight (P.C.F.)	Unconfined Compressive Strength (P.S.F.)	Allowable Bearing Strength (P.S.F.)
			Black silty clay, trace of sand					
	3'0"				15.4			
	4'4"		Hard brown silty clay					
NO.1 ST	6'0"							

Type of Sample

A Auger (Disturbed) —Split Tube Sampling—
H Thin-walled (Housel) Tube-Undisturbed
J Jar-Disturbed
ST Shelby Tube-Undisturbed
RC Rock Core
NR Indicates "No Recovery"

Remarks

Total Footage: 6'0"
Overburden Drilled: 6'0"
Rock Cored: NONE
Drillers: TK-TB-DF

Groundwater Observations

SOIL BORING LOG

Toledo Testing Laboratory, Inc.
1810 North 12th Street
Toledo, Ohio 43624
(419) 241-7175

Project WELL INSTALLATION - RIVERVIEW, MICHIGAN

Boring Location _____ Job No. DR-4686

Date JANUARY 22, 1981 Soil Boring No. 17

Sample & Type	Depth (Ft.-In.)		Top of well cap - Elevation - 590.86 Soil Description	Blows Per 6"	Moisture Content (%)	Dry Unit Weight (P.C.F.)	Unconfined Compressive Strength (P.S.F.)	Allowable Bearing Strength (P.S.F.)
			Fill - loose brown sand and gravel, some stones					
	8'0"							
NO.1 J				(13) (3) (4)				
	9'6"							
	12'0"							
			Grey silty clay, some gravel					
	14'0"							
NO.2 C. J								
	15'6"							
	18'0"							

Type of Sample

A Auger (Disturbed)
—Split Tube Sampling—
H Thin-walled (Housel) Tube-Undisturbed
J Jar-Disturbed
ST Shelby Tube-Undisturbed
RC Rock Core
NR Indicates "No Recovery"

Remarks

Total Footage: 18'0"
Overburden Drilled: 18'0"
Rock Cored: NONE
Drillers: TK-TB-DF

Groundwater Observations

SOIL BORING LOG

Toledo Testing Laboratory, Inc.
1810 North 12th Street
Toledo, Ohio 43624
(419) 241-7175

Project WELL INSTALLATION - RIVERVIEW, MICHIGAN

Boring Location _____ Job No. DR-4686

Date JANUARY 22, 1981 Soil Boring No. 18

Sample & Type	Depth (Ft.-In.)	Soil Description	Blows Per 6"	Moisture Content (%)	Dry Unit Weight (P.C.F.)	Unconfined Compressive Strength (P.S.F.)	Allowable Bearing Strength (P.S.F.)
		Top of well cap - Elevation: 591.05					
		Fill - grey sand, gravel and stone					
	3'0"						
	4'0"	Fill - black gravel, some sand, little silt and clay					
NO 1							
D, J	5'6"						
	6'0"						

Type of Sample

A Auger (Disturbed) —Split Tube Sampling—
H Thin-walled (Housel) Tube-Undisturbed
J Jar-Disturbed
ST Shelby Tube-Undisturbed
RC Rock Core
NR Indicates "No Recovery"

Remarks

Total Footage: 6'0"
Overburden Drilled: 6'0"
Rock Cored: NONE
Drillers: TK-TB-DF

Groundwater Observations

SOIL BORING LOG

Toledo Testing Laboratory, Inc.
1810 North 12th Street
Toledo, Ohio 43624
(419) 241-7175

Project WELL INSTALLATION - RIVERVIEW, MICHIGAN

Boring Location _____ Job No. DR-4686

Date JANUARY 22, 1981 Soil Boring No. 19

Sample & Type	Depth (Ft.-In.)	Soil Description	Blows Per 6"	Moisture Content (%)	Dry Unit Weight (P.C.F.)	Unconfined Compressive Strength (P.S.F.)	Allowable Bearing Strength (P.S.F.)
		Fill - black sand, gravel and brick					
	3'0"						
		Grey sand					
	4'0"						
		Grey silty clay, little gravel					
NO.1 ST	5'9"			18.4			
	6'10"						
	7'0"						

Type of Sample

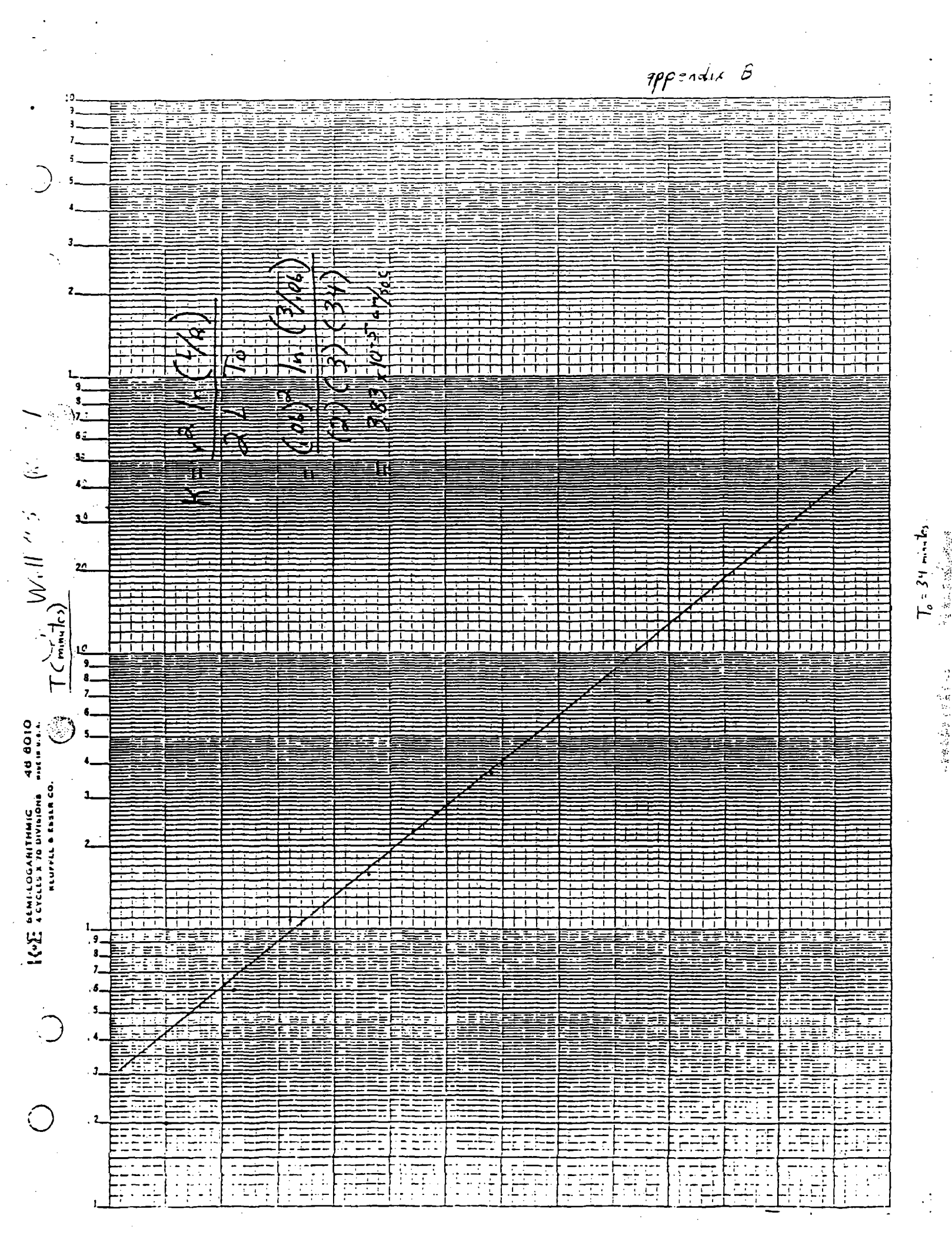
A Auger (Disturbed) —Split Tube Sampling—
H Thin-walled (Housel) Tube-Undisturbed
J Jar-Disturbed
ST Shelby Tube-Undisturbed
RC Rock Core
NR Indicates "No Recovery"

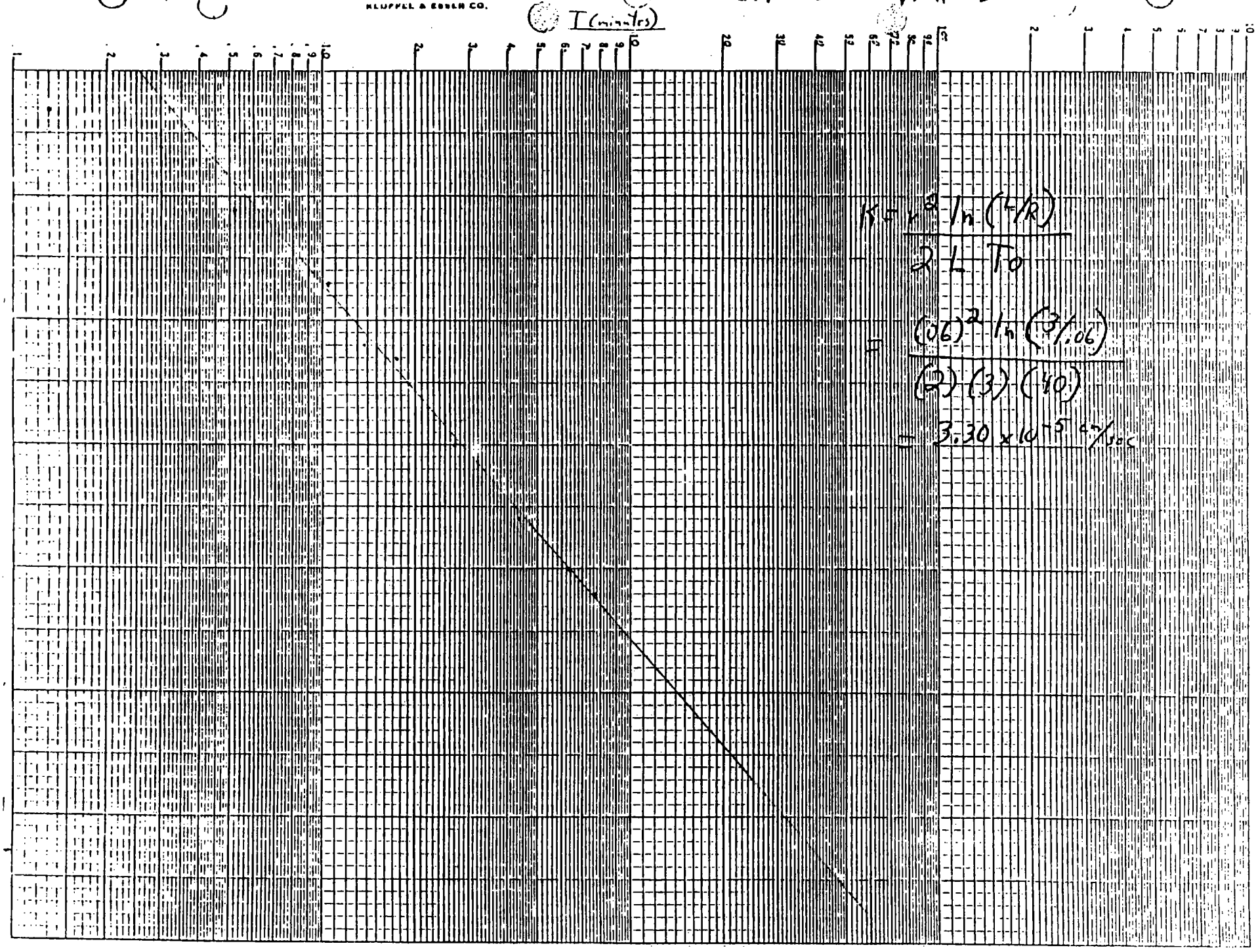
Remarks

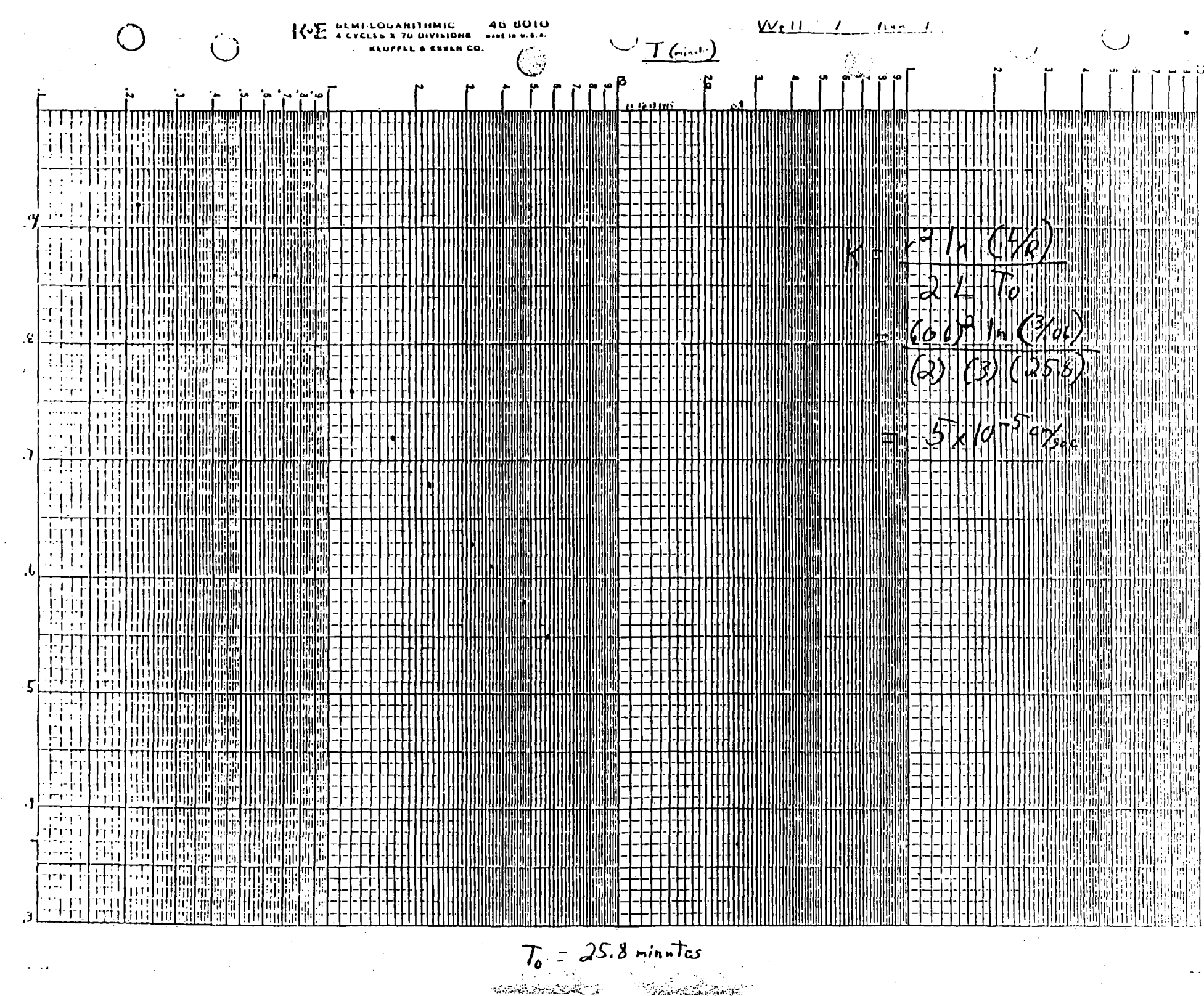
Total Footage: 7'0"
Overburden Drilled: 7'0"
Rock Cored: NONE
Drillers: TK-TB-DF

Groundwater Observations

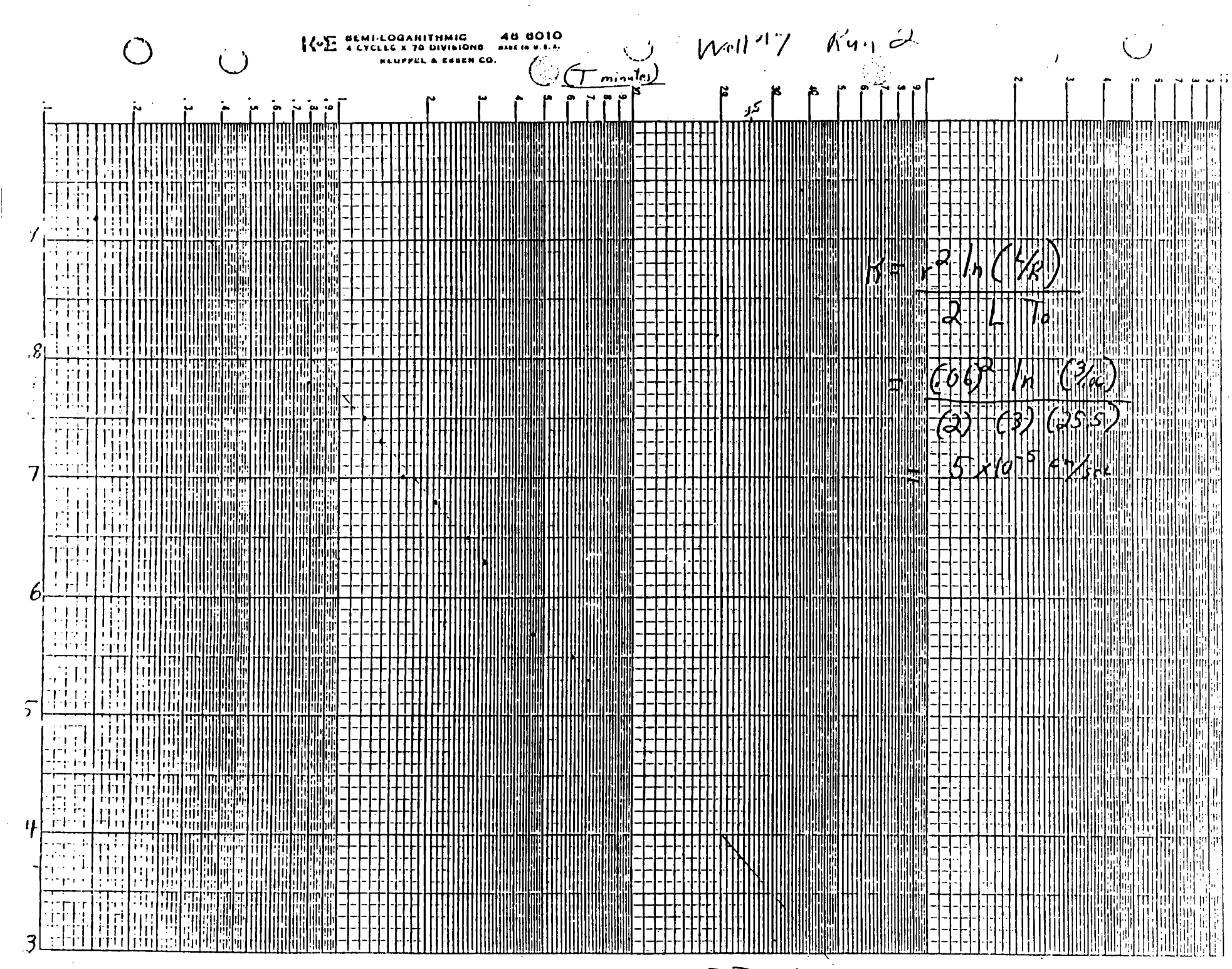
Appendix B


$K = \frac{2.3Q}{4\pi s} \log\left(\frac{2.25Tt}{r^2}\right)$
$K = \frac{2.3(3.06)}{4\pi(3.41)} \log\left(\frac{2.25(3.06)t}{(1.5)^2}\right)$
$K = 0.83 \log\left(\frac{3.06t}{2.25}\right)$
$T_o = 34$ minutes
T (minutes)
Well
1 CYCLE X 70 DIVISIONS
KEUFFEL & ESSER CO.


K&E SEMI-LOGARITHMIC 46 6010
4 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO.
Well #3 Run #2
t (minutes)
$K = \frac{x^2 \ln(t/R)}{2 L T_0}$
$= \frac{(.06)^2 \ln(3/.06)}{(2)(3)(40)}$
$= 3.30 \times 10^{-5}$ ft/sec
$T_0 = 40$ minutes


K&E SEMI-LOGARITHMIC 46 8010
4 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO.
Well 1
T (minutes)
$K = \frac{r^2 \ln(4/R)}{2 L T_0}$
$= \frac{(6.6)^2 \ln(3/.05)}{(2)(3)(25.8)}$
$= 5 \times 10^{-5}$ cm/sec
T_0 = 25.8 minutes

Appendix B


K&E SEMI-LOGARITHMIC 46 8010
4 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO.
Well #7
(T minutes)
$K = \frac{r^2 \ln(t/t_0)}{2 L T_0}$
$= \frac{(.06)^2 \ln(3/.02)}{(2)(3)(25.5)}$
$= 5 \times 10^{-5}$ ft/sec
$T_0 = 25.5$ minutes

APPENDIX C

The volume of water discharged from the groundwater to the Trenton Channel of the Detroit River can be estimated using Darcy's Law:

$Q = -KIA$ where,

Q = volume of water, $ft^3/yr.$

K = hydraulic conductivity, cm/sec or ft/yr

I = hydraulic gradient

A = area through which groundwater discharge occurs, ft^2

V = specific discharge

ne = effective porosity

Assumptions:

$K = 4 \times 10^{-5}$cm/sec or 40 ft/yr.

I = .015

A = 12 ft x 1100 ft = 13200 ft^2

ne = 15%

Therefore:

Q = 40 ft/yr x .015 x 13200 ft^2

= 7920 $ft^3/yr.$ or approx. 59,000 gal/yr.

To estimate the velocity that water is moving toward the channel we calculated the specific discharge using the same assumptions:

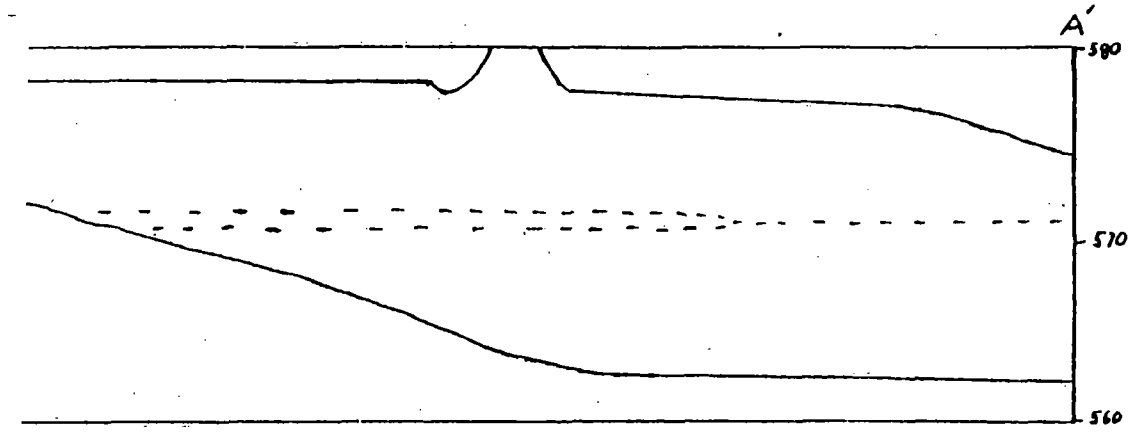
$$V = -KI \frac{1}{ne}$$

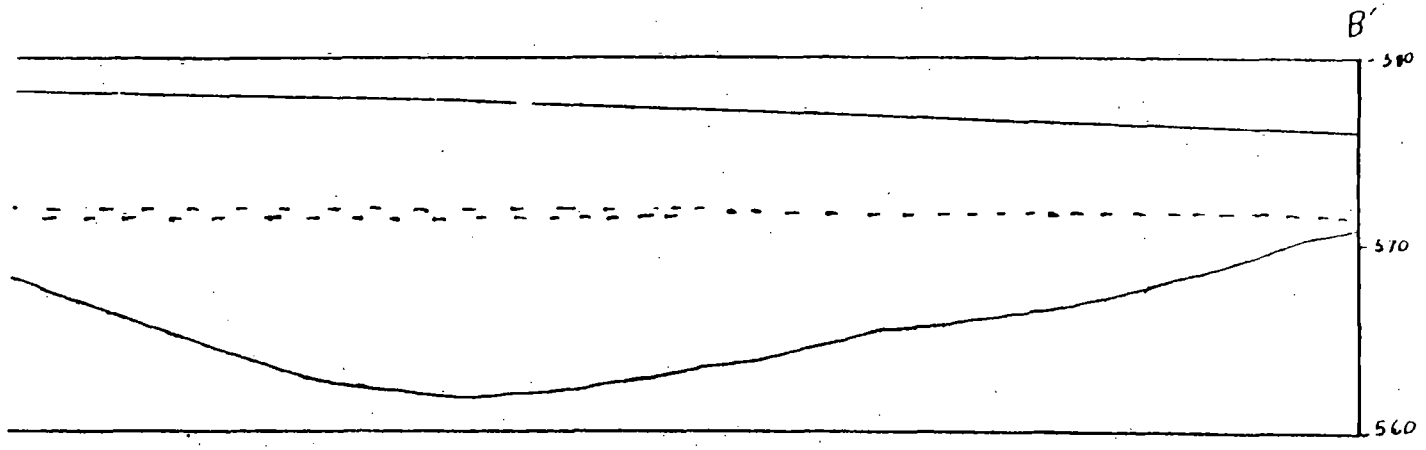
V = .40 ft/yr x .015 x 6.66

V = 4 ft/yr.

These figures represent what is probably a worst case estimate due to the fact that the gradient becomes less in the northeast corner of the porerty. Also, since the water level measurments from which this data is generated were taken in the spring, the total cross sectional area of the saturated zone above the clay is probably at or near it's greatest size.

MH/df





rtical Scale 1"=10'

ıri zontal Scale 1"=100'

Federal Marine Terminals

Riverview, Michigan